PATENT SPECIFICATION 633,776

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COMPLETE SPECIFICATION.

Improved Processes and Apparatus for the Vacuum Flotation Treatment of Coal, Ores and the like.

I, WILLIAM JOHN SUTTON, a British subject, of The Red House, 24, Nelson Road, Lexden, Colchester, Essex, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to processes and apparatus for the cleaning of coal, the concentration of ores and like operations by vacuum flotation treatment, in which a vacuum is applied to a pulp comprising a mixture of a mineral, for example, coal or ore, and water, with a small amount of oil, for example, paraffin or fuel oil, the particles of the mineral becoming attached to air bubles released from the water by the vacuum, whilst the refuse or gangue remains unaffected, so that the particles of the mineral rise to the surface of the water and the refuse or gangue sinks under the action of gravity, and the two products may thus be recovered separately.

The invention is especially applicable to vacuum flotation apparatus of the kind exemplified by the apparatus described in the Patent Specification No. 505,688, in which the pulp is introduced into a separation chamber at more than one point by distributor means located within the chamber and the clean coal, ore or the like is withdrawn through a central outlet pipe extending substantially vertically within the separation chamber and having its open mouth situated in the upper part of the chamber, the process water being also withdrawn separately from the upper part of the chamber while the refuse or gangue is discharged from the lower part. The invention may be applied with advantage, however, to apparatus other than that defined if the construction of the apparatus is adapted for modification in accordance with the invention.

In vacuum flotation processes it is not in all cases possible to secure the maximum recovery of pure coal, ore or the like in the flotation product and it is recognised that in order to complete the recovery a retreatment of a part or the whole of the flotation product and particularly the refuse or gangue then becomes essential. Thus, in a coal slurry separation treatment, it may be necessary to retreat the refuse and possibly the clean coal froth.

The invention has among its objects to effect such retreatment economically, to effect dewatering of the coal or like froth under vacuum, to secure a flotation product of a high degree of purity, to facilitate rapid filtration of the flotation product to provide for the introduction into the apparatus of air under control during the continuance of the process as may be desirable and generally to effect improvements in the process and in the apparatus.

According to the invention, in a vacuum flotation process for the cleaning of coal, the concentration of ore or a like operation, the retreatment of the refuse or gangue or waste product, or alternatively of the clean or concentrated product is effected simultaneously with the primary separation as a continued operation and carried out in a single apparatus.

The retreatment is advantageously effected in a separation chamber or vessel forming a component of the main vacuum flotation apparatus and adapted to receive the product to be treated intermediate the upper and lower ends and to discharge the froth formed by the coal, ore or like content of the retreated product at the upper part while the refuse or gangue of the said product is discharged from the lower part.

The discharge of the froth may be effected to one or more collecting launders, channels or the like that may also receive the froth resulting from the primary separation treatment, or if preferred kept separate.

The froth, on entering the collecting launder, channel or the like, may be caused to contact or flow over a screen or screens whereby a large proportion of free liquid

may be separated therefrom, thus reducing the volume of liquid to be removed subsequently from the flotation product by filtration or otherwise. Since the separation is effected under a partial vacuum, the froth bubbles, which have been formed under a vacuum, do not readily collapse and therefore do not pass through the screen or screens. The flotation product, also, is of a high degree of purity, since, for instance, in the case of coal, the free water separated from the froth contains impurities in the form of ash-forming constituents of the coal that would otherwise contaminate the product. The quality or grade of coal cleaned in the manner described is superior to that of coal treated by the vacuum flotation process in the absence of the step of dewatering. Further the reduction in the content of water in the clean coal froth and the consequent higher content of solids has, as a result, the advantage that the froth is more readily drained or filtered, so that filtration is expedited or a filter of a smaller capacity than would otherwise be required may be used.

Provision may advantageously be made for the introduction under control, of air into the pulp to be separated, as required. The air may be supplied in the feed of the pulp, for example, by way of a diffuser, and it may be drawn into the separation chamber by reason of the partial vacuum in the said chamber. It may alternatively be introduced directly into the liquid in the chamber. If the conditions in any instance require the introduction of considerable volumes of air, pressure may be used for the purpose.

The invention further comprises the improved processes and the improved apparatus hereinafter more fully dsecribed.

An example of vacuum flotation apparatus according to the invention is illustrated in the accompanying diagrammatic drawings, in which:—

Figure 1 is a view in elevation of the apparatus,

Figure 2 is a plan view of the apparatus represented in Figure 1,

Figure 3 is a sectional elevation, to an enlarged scale, of the separation chamber or vessel in which the retreatment of the waste or other product is effected,

Figure 4 is a plan view corresponding to Figure 3, and

Figure 5 is a vertical cross-section of one of the froth collecting launders, to a larger scale.

The apparatus represented in the accompanying drawings is especially suitable for the cleaning of fine coal, while being adaptable to other operations. The primary or main separation chamber 1 is of double conical formation in which the upper cone 2 is truncated in a greater degree than the lower cone. The cone 2 is provided with an inner wall 3 which is continued downwardly to the required extent as an inner wall for the upper part of the lower cone. There is thus formed an annular space 4 between the double walls. At the upper part of the said space provision is made for the discharge of the process water over an annular weir or into an annular overflow discharge trough (not illustrated), whereby a constant liquid level may be maintained in the separation chamber 1. A convenient form of such overflow discharge trough and associated parts is described in the Specification No. 505,688. Other means of maintaining a constant liquid level, however, may be employed.

Concentrically within the separation chamber 1 there is disposed the cylinder 5, adapted to serve as the retreatment chamber. The upper edge extends slightly above the constant liquid level and the lower edge is joined to a truncated cone 6, which is connected to a cylindrical outlet fitting 7 that surrounds the centrally disposed outlet pipe 8 by which the clean coal, froth or other flotation product leaves the apparatus. The fitting 7 has an annular bottom plate 9, inclined to the axis, and is connected to an inclined outflow pipe 10. The outlet pipe 8 is surmounted by a truncated cone 11 spaced from the cone 6 and having its upper edge secured to the inner face of the cylinder 5. A third cone 12 is spaced above the cone 11 and at the lower end is connected to an outflow pipe 13 that is positioned centrally in the pipe 8 and diverted outwardly beneath the bottom plate 9 of the fitting 7. A fourth cone 14, truncated so that it is of small depth, is secured to the inner face of the cylinder 5 at a short distance above the cone 12 and extends into the said cone. An overflow trough 15, adapted to the constant level, is fitted at the upper end of the cylinder 5 and the inner face of the cylinder is fitted with vertical baffle plates 16 in spaced positions. The product to be retreated is received into the cylinder by way of a supply pipe 17 that preferably is provided with an outlet or outlets 18 adapted to discharge the product in a tangential direction into the cylinder above the cone 14.

A series of collecting troughs or launders 19 extend in spaced positions from the exterior of the cylinder 5 to the inner face of the wall 3 of the separation chamber 1 with their upper edges set at the constant level. Each collecting trough or launder is of a right-angled triangular form in elevation, the base being set along the wall of the cylinder 5 and the hypotenuse extending in continuation of the wall of the cone

6. The walls are parallel, except near the upper edges where they are formed with inwardly inclined lips 20. Each is divided into two parallel compartments by a longitudinal partition 21 which terminates at a distance below the lips 20 such that a separating screen 22 may extend from the base of one of the lips 20 to the upper edge thereof at an angle to the horizontal of not less than 45°, but preferably greater. A guide plate 23 is provided at the upper edge of the lip 20 of the opposite wall and is of a width to extend into proximity with the screen 22 in order to direct thereon the inflow from each lip. It may be set normal to the screne or at an angle thereto may be adjustable. The screen may also be angularly adjustable, to accommodate varying conditions and requirements. The screen elements are advantageously of wedge wire, and prevent the passage of the bubble-sustained particles of the coal or other mineral, thus avoiding the collapse of the air bubbles to any appreciable extent, while permitting free water to pass through into the screened compartment 24 of the collecting trough or launder, the froth and mineral being delivered by the screen into the open compartment 25.

The overflow trough 15 of the cylinder 5 is adapted to discharge into the compartments 25 of the collecting troughs or launders 19 through orifices 26 and there may be provided in the trough 15 between the adjacent orifices shaped guide plates 27 serving to direct the outflow to the orifices. The trough 15 may alternatively be adapted to discharge into the launders 19 by way of weir plates, chutes or the like delivering the outflow on to the guide plates 23 or on to the screens 22. The compartments 24 of the launders are in communication with the cone 6 by way of orifices 28 in the cylinder 5, and the compartments 25 are similarly in communication with the cone 11 by way of orifices 29. Between the cones 12 and 14 the cylinder is formed with orifices 30 that afford communication between the cylinder and the interior of the separation chamber 1, in order to ensure that the constant level of liquid is attained in each. In view of the difference in elevation of the orifices 28 and 29 in the wall of the cylinder 5, the bottom plate of the compartment 25 of each launder 19 is advantageously inclined at a corresponding angle, in order to secure a free flow through the orifices 29 of the froth and mineral.

An annular wall 31 is disposed at the outer edges of the launders 19 to separate them from the surrounding annular space 4 by which the process water leaves the separation chamber 1. The said wall may also serve to form a connection or joint with the cover by which the separation chamber is rendered airtight to permit the formation therein of a partial vacuum.

The pulp to be treated in the separation chamber 1 is supplied thereto by a supply conduit 32 that is branched to deliver the pulp by way of distributor heads 33, advantageously set one in each of the spaces between adjacent launders 19 and at an elevation substantially that of the junction of the cones forming the separation chamber 1. An air diffuser 34 may be fitted to the supply conduit 32 at a convenient position and may serve for the introduction of secondary air into the pulp, as may be considered necessary. The air diffuser may be operated without the use of an air compressor or the like, since the vocuum in the separation chamber will enable the air to be drawn into the diffuser, under regulation by a valve 35. The refuse or gangue from the separation chamber 1 is discharged by way of the outlet fitting 36 and the discharge pipe 37.

In the operation of the apparatus hereinbefore described, as applied to the cleaning of fine coal, while separation of the pulp is proceeding in the separation chamber 1, the refuse previously discharged by the pipe 37 is supplied to the cylinder 5 by the pipe 17, and in view of the tangential discharge from the outlet or outlets 18, acquires a rotary or whirling movement in the cylinder, thereby being uniformly distributed. As the coal-laden froth rises the rotary movement is arrested by the baffles 16. The froth overflows the upper edge of the trough 15 and is thence directed through the orifices 26 into the compartments 25 of the launders 19, after flowing over the screens 22 if the latter are positioned to receive it. The froth passes from the compartments 25 by the orifices 29 into the cone 11, and thence is discharged by the pipe 8. At the same time, the refuse sinks through the cone 14 to the cone 12 and passes away by the pipe 13.

In the meantime, in the separation chamber 1, outside the cylinder 5 and in the spaces between the launders 19, the distributor heads 33 are introducing pulp whence coal-laden froth rises to the surface of the water in the chamber and passes over the lips 20 of the launders, being directed by the guide plates 23 to flow over the screens 22 and thus freed in the manner hereinbefore described of the greater part of the water, which passes away through the compartments 24 and by way of the orifices 28 into the cone 6, whence it is discharged through the fitting 7 and the pipe 10. The dewatered froth passes into the compartments 25 and is discharged in the manner before described. The refuse separating from the pulp sinks through the lower cone of the separation chamber 1

and is discharged by way of the fitting 36 and the pipe 37, to be returned to the cylinder 5, as hereinbefore described. The water from which the refuse separates passes away from the separation chamber 1 by way of the overflow trough in the annular space 4.

The refuse discharge pipe 13 is provided of sufficient length to act as a barometric leg, the lower end of which is submerged in a water seal tank. The refuse discharge pipe 37 is similarly provided.

The cylinder 5 and the launders 19 are advantageously provided to be vertically adjustable in relation to the constant liquid level. For this purpose the outlet pipe 8 may be in two lengths, the upper length being secured in fixed relation to the cylinder and the launders and being connected to the lower length by a rubber or like flexible sleeve or bellows. The adjustabilty of the cylinder and the launders may be provided for by other means and may necessitate corresponding construction of associated parts. For example, it may be necessary to provide the supply pipe 17 of a form to permit the desired adjustment.

It will be understood that the invention is not limted to the details of the construction of the apparatus as hereinbefore described. Modifications may be effected as may be required according to particular applications. For example, in order to faciltate the smooth ascent of the froth to the surface of the liquid in the retreatment chamber or vessel, the wall of the latter may be coned or streamlined immediately beneath the overflow trough or the trough may be positioned exterior to the chamber or vessel. Again, the tangential flow of the product to be retreated on introduction into the chamber or vessel may be omitted and the number of inlets for the product be increased.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for the vacuum flotation treatment of coal, ores and the like, in which retreatment of the refuse, gangue or waste product, or of the clean or concentrated product, is effected simultaneously with the primary treatment as a continued operation in a single apparatus.

2. A process for the vacuum flotation treatment of coal, ores and the like, in which primary treatment of the pulp is effected simultaneously with the retreatment of a product of the primary treatment in a continued operation and the froth resulting from both treatments, after separation and while still subject to the vacuum, is deprived of free water without appreciable loss of air bubbles.

3. Apparatus for the cleaning of coal, the concentration of ores and for like operations effected by vacuum flotation treatment, in which a separation chamber or vessel is provided for the purpose of effecting a retreatment of the refuse, gangue or waste product, or of the clean or concentrated product simultaneously with the primary treatment in a single apparatus, the said separation chamber or vessel receiving the product to be retreated intermediate the upper and lower ends and being adapted to discharge the froth formed by the coal or like content of the said product from the upper part and the refuse or gangue of the said product from the lower part.

4. Apparatus according to claim 3, in which the froth laden with coal or the like s received into one or more collecting launders, channels or the like.

5. Apparatus according to Claim 4, in which the froth separated in the retreatment chamber or vessel passes to the collecting launder, or launders in which is received the froth from the primary separation.

6. Apparatus according to Claim 3, in which the retreatment chamber or vessel is a cylinder closed at the lower part by a cone from which the refuse or gangue is discharged and provided at the upper end for the overflow of the froth to a number of spaced and outwardly radiating collecting launders.

7. Apparatus according to any of Claims 3 to 6, in which the froth is received into collecting launders, channels or the like that are divded into two compartments one of which is surmounted by a screen over which the froth flows in passing into the second compartment, thereby being deprived of free water which passes through the screen into the first compartment.

8. Apparatus according to Claim 7, in which the screen is set at an angle to the horizontal of not less than 45°.

9. Apparatus according to Claim 7 or 8, in which the froth is received over oppositely disposed and parallel lips of a ocllecting launder and is caused to flow over an inclined guide plate to the screen.

10. Apparatus according to Claim 9, in which the screen and/or the guide plate may be angularly adjusted.

11. Apparatus according to any of Claims 6 to 10, in which each collecting launder is formed into two compartments respectively receiving froth deprived of free water and the separated free water and the retreatment chamber or vessel is provided below the cone discharging refuse or gangue with spaced coaxial cones which respectively collect from the several launders through corresponding orifices in the walls

of the chamber or vessel, the free water and the froth which are separately discharged by the said cones.

12. Apparatus according to any of Claims 6 to 11, in which the product to be retreated is introduced tangentially into the cylindrical retreatment chamber or vessel to secure effective distribution.

13. Apparatus according to Claim 12, in which the upper part of the cylinder is provided with spaced vertical baffle plates for arresting the rotary movement of the liquid contents of the cylinder to ensure the quiescent flow of the froth to the overflow.

14. Apparatus according to any of claims 6 to 13, in which the retreatment chamber or vessel is provided at the upper part with an overflow channel or trough whence the froth is discharged into the respective collecting launders, channels or the like.

15. Apparatus according to Claim 14, in which the discharge of the froth is effected from the overflow channel or trough through spaced orifices to which the froth is guided by baffles.

16. Apparatus according to any of claims 3 to 15, in which secondary air is introduced into the main separation chamber with the feed of pulp.

17. Apparatus according to Claim 16, in which an air diffuser is provided in association with the feed pipe.

18. Apparatus according to Claim 16 or 17, in which the air is introduced under control and under suction, by reason of the vacuum maintained in the separation chamber.

19. Apparatus for effecting the retreatment of a product resulting from the vacuum flotation treatment of coal, ores or the like, substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

20. Apparatus for effecting the vacuum flotation treatment of coal, ores or the like, provided with froth-collecting launders, channels or the like, substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

Dated the 10th day of June, 1947.

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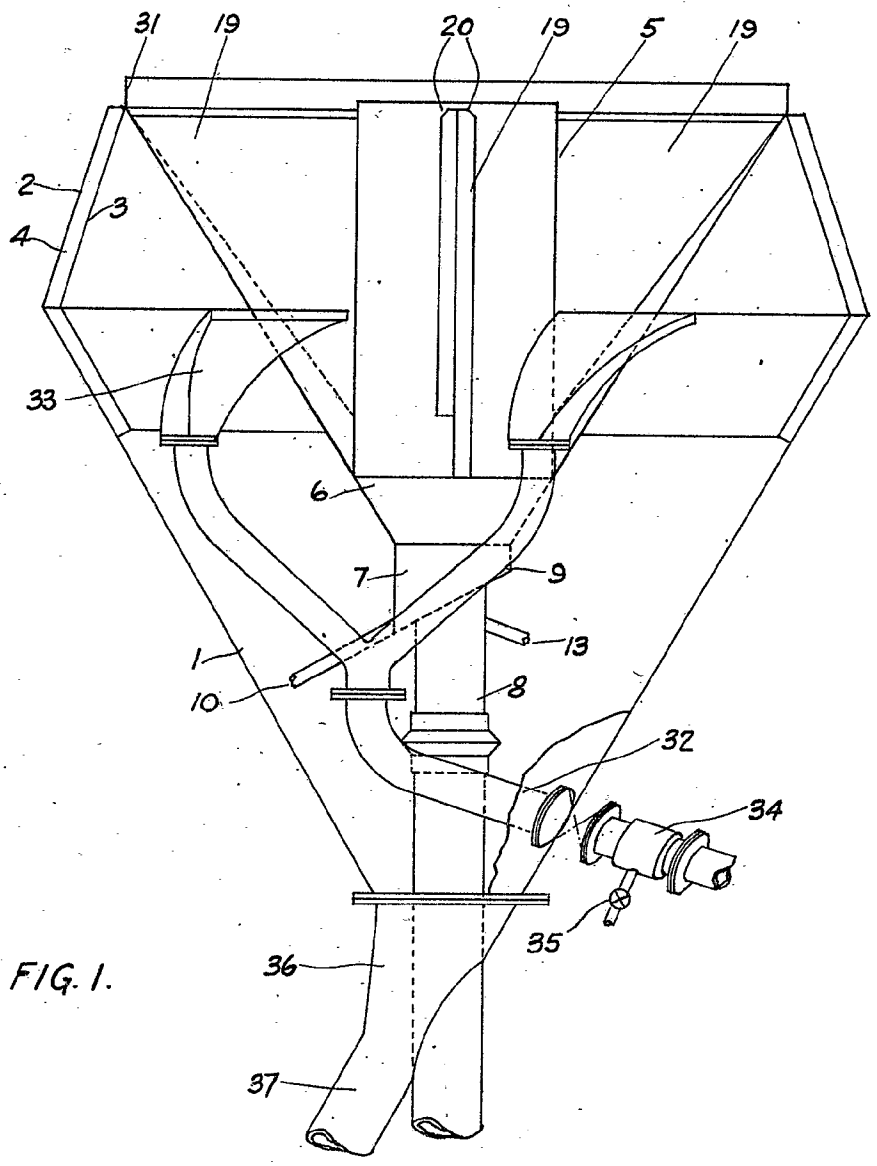

FIG. 1.

H.M.S.O. (Ty.P.)

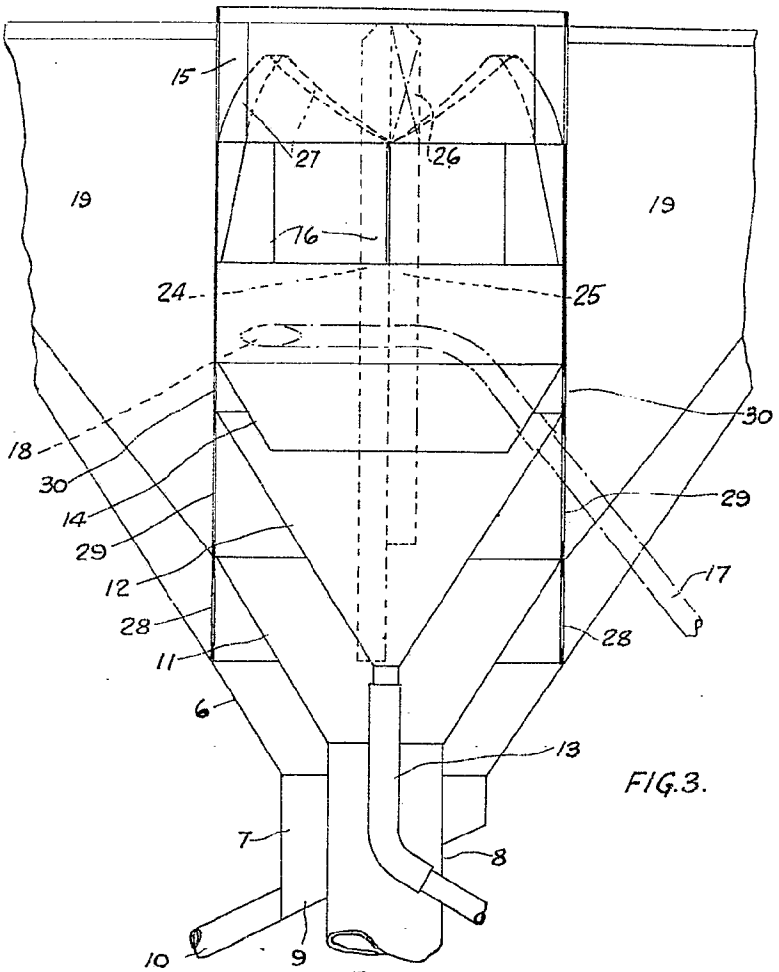

FIG. 3.

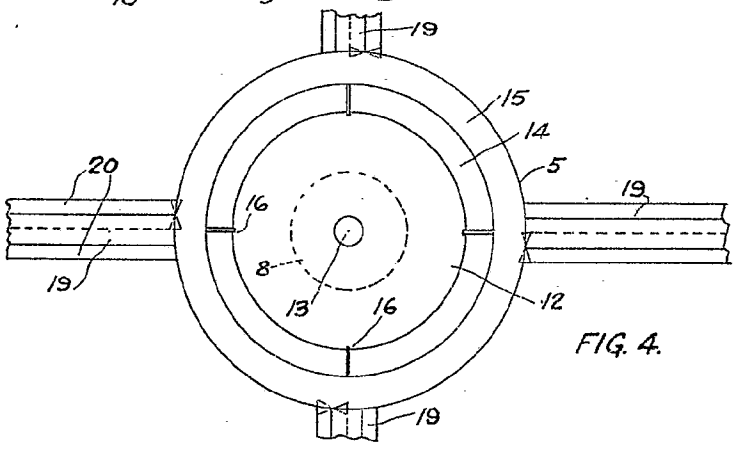

FIG. 4.

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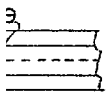

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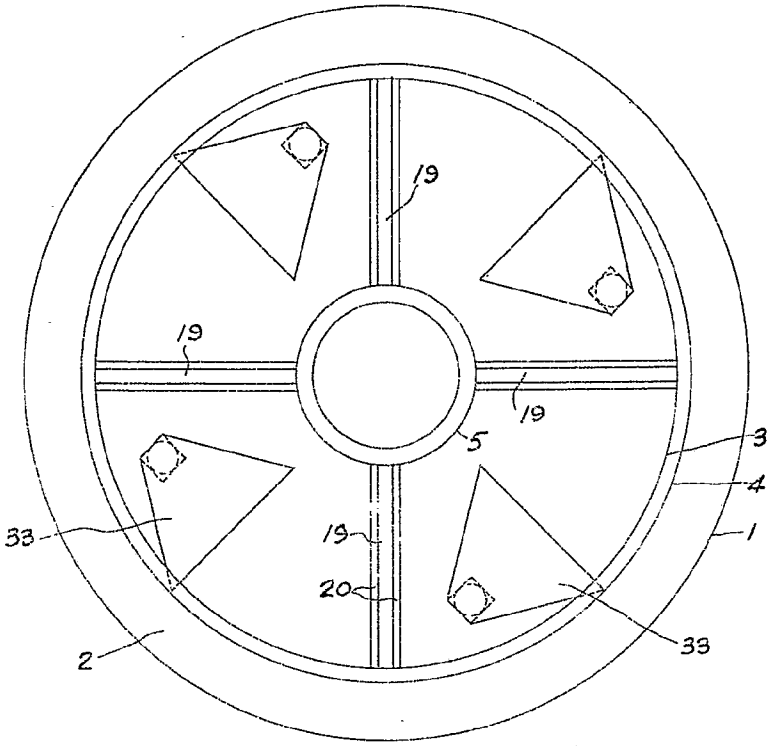

FIG. 2.

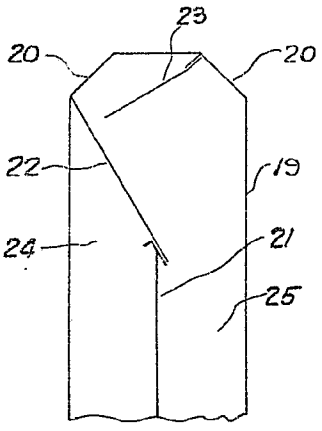

FIG. 5.

H.M.S.O.(Ty.P.)

633,776 COMPLETE SPECIFICATION

3 SHEETS

SHEET 2

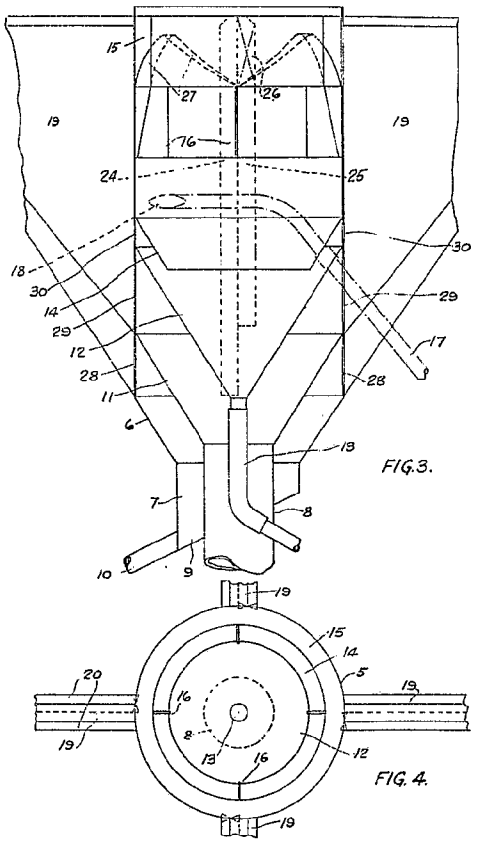

FIG. 3.

FIG. 4.

SHEET 3

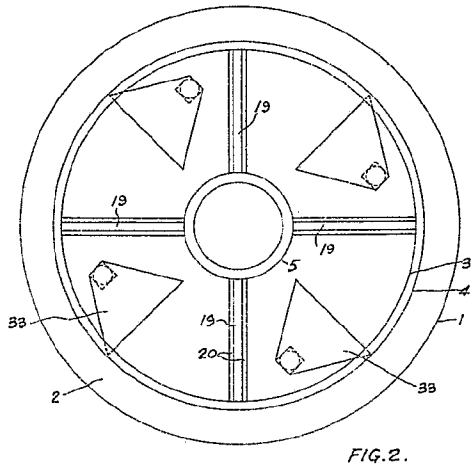

FIG. 2.

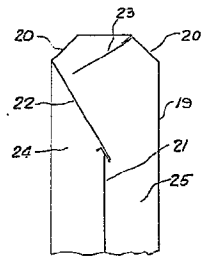

FIG. 5.

[This Drawing is a reproduction of the Original on a reduced scale.]

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